THE DISTRIBUTION OF BEACH PLANTS

EDITH A. ROBERTS

The following observations were made of the distribution of plants on the lower and middle beaches of the coasts of the Elizabethan Islands and Falmouth. The Elizabethan Islands and Falmouth are situated in eastern Massachusetts, Falmouth being a part of the mainland, and the islands extending in a chain into the ocean, bordered by Buzzard's Bay on the west and by Vineyard Sound on the east.

The facts here noted were observed while I was collecting material for the investigation of the osmotic pressure of succulent plants in the above-named localities. A more or less definite grouping of the succulents was found, and, when present, certain plants were always in advance, where they would the more often be covered by the salt water. Later investigation will attempt to show whether the different locations on the beaches present more or less difficult situations for maintenance of growth, and, if so, whether there is a greater or more variable osmotic pressure among the forms to account for their being able to occupy more adverse situations. Competition of species cannot account for the presence or absence of forms, for GANONG (**6**) has shown that the ground is not already occupied, therefore the struggle must be with the physical environment.

Thirteen locations were selected as affording types of all shores on the Islands and Falmouth where succulents might be found. These may be divided into sea beach and sea cliff types. The coasts of the sea beach type are readily divided into lower, middle, and upper beaches according to COWLES (**4**). The upper beach in all cases is a low dune, back of which there is always found a pond. The dune at Chappaquoit Point is the highest.

The sea cliffs may be divided into two classes: those at whose base the rise and fall of water varies so little that a zone of *Zostera marina* is present and those at whose base this plant is absent. The sea beach type was found at Chappaquoit Point, Falmouth

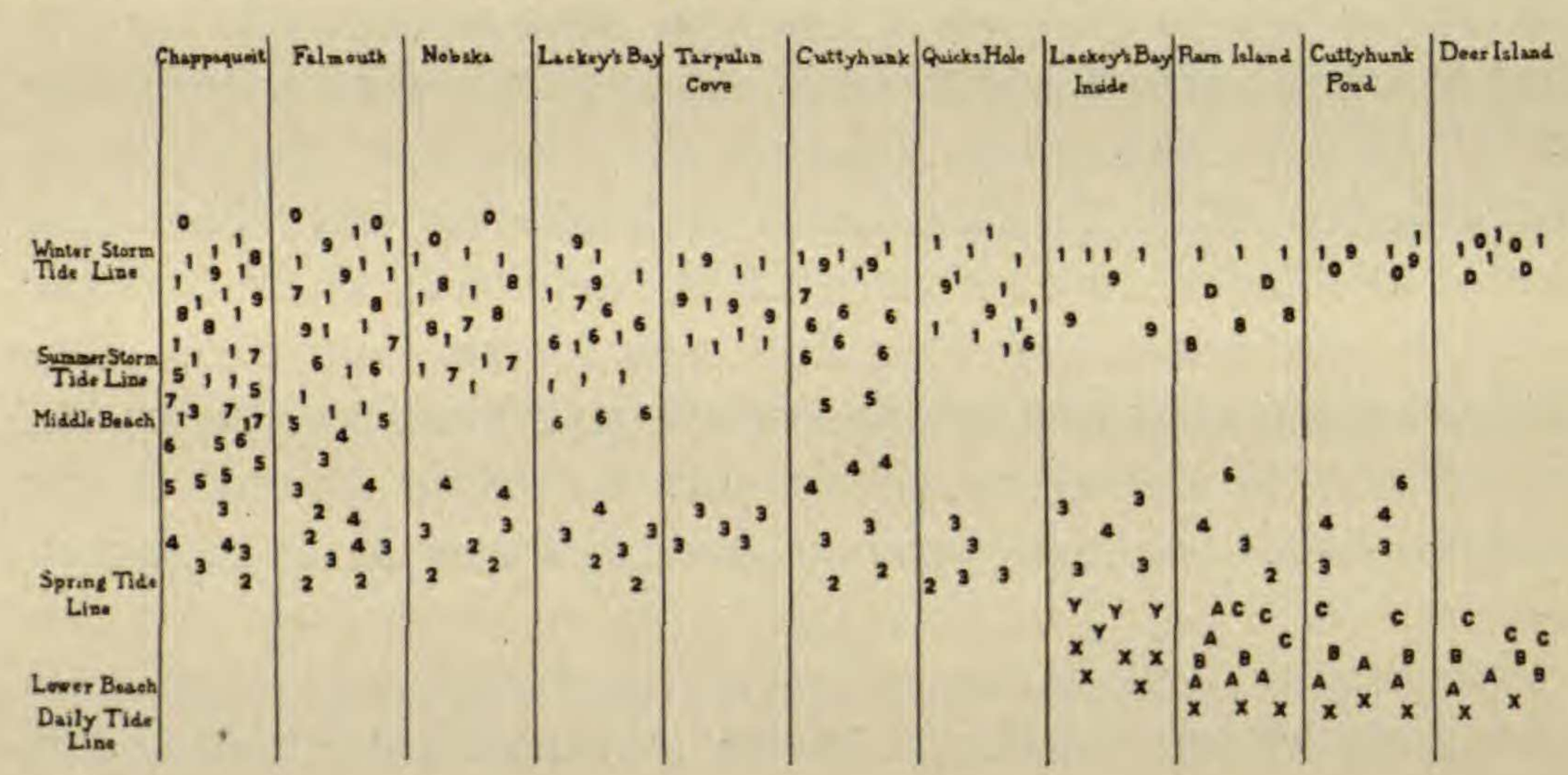
Beach, Nobska Beach, Lackey's Bay, Tarpaulin Cove, Cuttyhunk, and Quicks Hole. The sea cliff without *Zostera marina* was found at Nobska Cliff and Falmouth Cliff. The sea cliff with *Zostera marina* was found at Lackey's Bay (inside), Ram Island, Cuttyhunk Pond, and Deer Island.

The following 9 plants were the characteristic succulents found on the middle beach: *Atriplex arenaria*, *Salsola Kali*, *Chenopodium rubrum*, *Arenaria peploides*, *Cakile edentula*, *Artemisia Stelleriana*, *Solidago sempervirens*, *Euphorbia polygonifolia*, and *Lathyrus maritimus;* while *Ammophila arenaria* has been included in the chart as a tenant of the middle beach because it plays a part in the zonal distribution of some of the succulents. SNOW (7) speaks of the upper part of the middle beach as the low *Ammophila* zone, thus subdividing the middle beach into the succulent zone (lower half) and low *Ammophila* (upper half). The drift spoken of as limiting the middle beach at the front is the daily tide line. The spring tide line seems to sweep back the daily tide débris, together with its own gatherings, to a line back of the daily tide. This irregular line of débris at the front of the lower middle beach, determined by the spring tide, marks the extent forward of the succulent zone, while the summer storm tide line marks the beginning of what I term the transitional zone, corresponding, I believe, to the low *Ammophila* zone of SNOW. Succulents and *Ammophila* tenant the region together, with the *Ammophila* dominating just back of the winter storm tide line or on the upper beach, the term *Ammophila* being thus used to apply to the upper beach. The plants exclusive of *Ammophila arenaria* were found in the order given as outpost plants as shown on the chart.

At Chappaquoit Point all the 10 characteristic plants were found. *Atriplex arenaria* was the forerunner, as it always is when present. BERGEN (1) states that *Salsola Kali* is the most tolerant of the plants he observed. It ranges here from *Artemisia Stelleriana* to just back of *Atriplex arenaria*, with some plants occasionally at the top of the dune. *Chenopodium rubrum* is confined to a region just back of *Salsola Kali*. *Arenaria peploides* grows in masses and monopolizes a wide zone. *Cakile edentula* grows more in bunches and is closely associated with *Artemisia Stelleriana*,

which often finds its best location at an *Ammophila arenaria* outpost. The *Artemisia Stelleriana* presents more or less of a solid front and only thin strands of *Ammophila* are found beyond; in fact, it might be said to define the border line of upper and middle beaches. *Euphorbia polygonifolia* becomes established on the wind-swept dunes, where there is nothing else, but never is found toward the ocean beyond the limit of *Ammophila* runners. *Lathyrus maritimus* occasionally extends into the transitional zone, but always in company with *Ammophila*.

At Falmouth there is an illustration of what is common at several of the beaches; at the region of the incoming daily tide there is a mass of dry eel grass and immediately back of that a



zone of small shingle, doubtless brought there by the stronger spring tide. At the limit of this shingle a slight depression occurs, then an elevation and the loose sandy zone with the succulents, and beyond this another depression, then an elevation rises slowly to the winter storm tide line.

At Nobska Beach *Chenopodium rubrum* is abundant, with only a little *Atriplex arenaria* and *Salsola Kali*, but wherever all three are present the same relationship holds, *Atriplex* being always nearer the water than the others.

Cakile edentula forms masses in front of *Ammophila* at Lackey's Bay. At Tarpaulin Cove much *Salsola Kali* is found in mats, and bunches of eel grass have been caught by it, forming stable mounds. The beach formed at Cuttyhunk Harbor and Vineyard Sound is

separated from Vineyard Sound by a high shingle mound. Among the shingle *Cakile edentula* grows most luxuriantly and forms thick, hedgelike masses. They are the most abundant and thrifty plants seen. Here the entire shingle strand must be washed often by the summer storms.

The relationship of the plants found at the base of Nobska Cliff and Falmouth is the same as that found on the beaches, but the tide lines are nearer together there, and the zones are condensed. The telescoping comes in the zone between the summer storm tide line and the winter drift, so that there is a more sudden transition from the succulent zone to the *Ammophila* zone, practically eliminating the transitional zone.

The low sea cliffs, at whose base the lower beach is eliminated and where there is living *Zostera marina*, as at Lackey's Bay, furnish an additional grouping. Here, on what corresponds to the plantless lower beach, is a grouping of *Zostera marina* and *Spartina glabra pilosa*. Their advance is checked by a mass of dry eel grass three feet in depth, but on the top of the eel gras, as on the substratum of the lower middle beach, is a grouping of succulent plants with exceptionally long roots. This is a strictly succulent zone, for the *Ammophila* does not advance beyond the eel grass débris. Why succulents can grow on the eel grass substratum and *Ammophila* not is an interesting question.

Along the cliffs where *Zostera marina* is present and the lower beach is covered by water, the following new forms are found: *Suaeda maritima*, *Salicornia europaea*, *Limonium carolinianum*, and *Ligusticum scoticum*. Their ecological relationship is shown on the chart. The last three divisions of the chart show what GANONG (5) speaks of as a *Salicornia-Suaeda* association. CHRYSLER (3) gives a list of plants arranged in a descending scale with respect to salt-resisting capacity, and in this *Salicornia europaea* is next to *Limonium carolinianum*. GANONG found that the root hairs of *Salicornia europaea* can endure 90 per cent of sea water without plasmolysis, and those of *Suaeda maritima* 60–70 per cent. CANNON (2) refers to salt-containing places as having marked zonal distribution; several species of *Atriplex* and *Suaeda* are nearer the center of salt spots, where the concentration of salt is highest.

Summary

1. The plants on the lower and middle beaches of some of the coasts of the Elizabethan Islands and Falmouth are found to have in general definite zonal distribution.

2. The shores may be divided into sea beach and sea cliff types; the latter may be subdivided into cliff types with *Zostera marina* and those without.

3. The following plants were selected as most representative of the beach type: *Ammophila arenaria*, *Atriplex arenaria*, *Salsola Kali*, *Chenopodium rubrum*, *Arenaria peploides*, *Cakile edentula*, *Artemisia Stelleriana*, *Solidago sempervirens*, *Euphorbia polygonifolia*, *Lathyrus maritimus*, and *Suaeda maritima*. *Salicornia europaea*, *Limonium carolinianum*, *Ligusticum scoticum*, *Zostera marina*, and *Spartina glabra pilosa* were taken as representatives of the sea cliff type.

4. The upper half of the middle beach is called the transitional zone.

5. When the lower beach is covered most of the time by water, *Suaeda maritima*, *Salicornia europaea*, and *Limonium carolinianum* are found in the order given, from ocean to shore.

6. The forms of the middle beach are found in definite zones, and when not present their places are not filled; for instance, *Atriplex arenaria*, *Salsola Kali*, *Chenopodium rubrum*, and *Arenaria peploides* are always found in the order given on the lower half of the middle beach, while *Cakile edentula*, *Artemisia Stelleriana*, *Solidago sempervirens*, and *Euphorbia polygonifolia* are related to *Ammophila* in distribution.

7. As to the cause of this distribution I hope to offer some suggestions in the near future.

MOUNT HOLYOKE COLLEGE

LITERATURE CITED

1. BERGEN, J. Y., Some littoral spermatophytes of the Naples region. BOT. GAZ. 41:327–333. 1906.
2. CANNON, W. A., Some relations between salt plants and salt spots. Leland Stanford Junior Univ. Publ. Dudley Memorial vol. 123–129. 1913.

3. Chrysler, M. A., Ecological plant geography of Maryland. Maryland Weather Service **3**:148–197. 1911.
4. Cowles, H. C., The ecological relations of the vegetation on the sand dunes of Lake Michigan. Bot. Gaz. **27**:94–117, 167–202, 281–308, 361–391. 1899.
5. Ganong, W. F., Vegetation of Bay of Fundy marshes. Bot. Gaz. **36**: 161–186, 280–302, 349–367, 429–455. 1903.
6. ———, The nascent forest of the Miscou beach plain. Bot. Gaz. **42**:81–106. 1906.
7. Snow, L. M., The ecology of the Delaware coast. Bot. Gaz. **34**:284–306. 1902.